SPECIFICATION, HARMONIZATION, AND LINKAGE OF TEST PARAMETERS

Edward D. Jones

This article addresses how to best specify "what to test" parameters. It will also clarify the latest DoD 5000 series guidance as approved by the Secretary of Defense on 9 March 1996 on the establishment and maintenance of parameter linkage and harmonization among the key acquisition documents.

While the newly revised Department of Defense (DoD) 5000 series does make significant progress implementing acquisition reform, confusion will likely continue to exist in the test and evaluation arena as to how to best specify test parameters for an acquisition program (Figure 1).

A proliferation of "what to test" terminology remains among the various parts of the DoD 5000 series. A formal glossary that will perhaps define these terms is still being compiled. On pages 149–151 is a partial listing of "what to test" terminology used in this article. For purposes of brevity, acronyms may not be defined except in this terminology list. Braces and brackets indicate an acquisition document where the term is used.

"WHAT TO TEST"

Some of the "what to test" terms may refer to the same required capabilities and associated thresholds and objectives. Often, they do not. Inherent relationships or linkages are not specified for most of these terms. Figure 2 summarizes the DoD 5000 series mandated sources for the most important "what to test" parameters.

The proper usage of "what to test" terms in reports and in discussions with oversight agencies can be important. Some of the terms have their origin in Title 10 law. For example, effectiveness and suitability are addressed in legislation that mandates how we will conduct dedicated initial operational test and evaluation. The test manager and program manager must

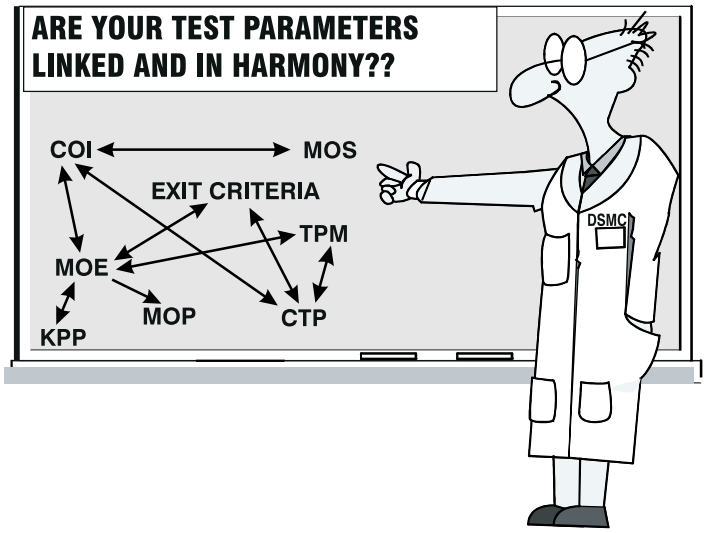

Figure 1.

take care when discussing what is actually being tested or evaluated. For example, assume a test for an ACAT ID acquisition program indicates that a threshold is not achieved for a TPM that is also a specified exit criteria.

Who has oversight for these test parameters? The contractor and government technical managers have oversight over TPMs. Unless the TPM is also designated as a critical technical parameter, it will not be listed in the TEMP and will normally not be subjected to Office of the Secretary of Defense (OSD) oversight at the overarching Integrated Product Team (IPT) level. However, all exit criteria by definition are under the direct oversight of the milestone decision authority (MDA). This means that failure to meet the threshold for an exit criteria could prevent the acquisition from proceeding into the next acquisition phase. This could be an emotional event! Compare this with failing to meet a threshold of TPM that is not a CTP or not specified to be an exit criteria. The contractor and government technical manager would take appropriate actions to solve the problem under the oversight of the program manger and the appropriate working level IPT. This article will recommend a method to specify test parameters that simplifies the "what to test" terminology.

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"WHAT TO TEST" TERMINOLOGY

Compatibility, Interoperability, and Integration (CII) Issues. {Appendix III, DoD REGULATION 5000.2-R} Defined to be critical operational issues that address compatibility, interoperability or integration issues. [Test and Evaluation Master Plan or TEMP]

Critical Operational Issue (COI). {Appendix III, DoD REGULATION 5000.2-R} A question that must be answered in order to properly evaluate operational effectiveness and operational suitability for a system. [TEMP]

Critical Operational Effectiveness and Suitability Parameters and Constraints. {Appendix III, DoD REGULATION 5000.2-R} Parameters and constraints as specified in the ORD that address manpower, personnel, training, software, computer resources, transportation (lift), compatibility, interoperability, and integration, etc. These parameters and constraints are included in the listing of measures of effectiveness and suitability in Part I of the TEMP. [TEMP, ORD]

Critical Technical Parameter (CTP). {Appendix III, DoD REGULATION 5000.2-R} Not defined. They are to be derived from the ORD, critical system characteristics, and technical performance measurements and should include the parameters in the acquisition program baseline. [TEMP]

Exit Criteria. {Paragraph 3.2.3, DoD REGULATION 5000.2-R} Exit criteria are some level of demonstrated performance (e.g., a level of engine thrust), the accomplishment of some process at some level of efficiency (e.g., manufacturing yield) or successful accomplishment of some event (e.g., first flight), or some other criterion (e.g., establishment of a training program or inclusion of a particular clause in the follow-on contract) that indicates that aspect of the program is progressing satisfactorily. [ADM]

Indicators. {Paragraph 3.4.3, DoD REGULATION 5000.2-R} One or more measurements that provide insight when compared with test-established thresholds. [Not mandated for usage in any key acquisition document; however, frequently used in test reports and program assessments.]

Key Performance Parameter (KPP). {Paragraph 2.3, DoD REGULATION 5000.2-R} A capability or characteristic that is so significant that failure to meet the threshold can be cause for the concept of system selection to be reevaluated or the program to be reassessed or terminated. [ORD, TEMP, Aquisition Program Baseline or APB]

Measures. {Used through out DoD 5000 series} Not defined. As defined in IEEE 1278.3, a qualitative or quantitative attribute used to ascertain or appraise by comparing to a standard. [TEMP, Analysis of Alternatives]

Measures of Effectiveness and Suitability (MOEs/MOSs). {Appendix III, DoD REGULATION 5000.2-R and in other parts} The following definition is inferred from a discussion of measures of effectiveness and suitability in Appendix III. The operational performance (effectiveness and suitability) parameters that specify capabilities, characteristics, and constraints as identified in the ORD. Each measure of effectiveness and suitability is to have a threshold and an objective. [TEMP, Analysis of Alternatives, ORD]

"WHAT TO TEST" TERMINOLOGY (CONTINUED)

Measure of Performance (MOP). {Paragraph 3.4.1; Appendix III, DoD REGULATION 5000.2-R} Not defined. A commonly accepted definition is: a measure, such as weight and speed, that relates to a measure of effectiveness such that the effect of a change in the measure of performance can be related to a change in the measure of effectiveness. {1992 OUSD (A&T) memorandum; subject: Implementation Guidelines for Relating Cost and Operational Effectiveness Analysis (COEA) Measure of Effectiveness to test and evaluation.} [TEMP, ORD Analysis of Alternatives]

Metrics. {Paragraph 4.3, DoD REGULATION 5000.2-R} Not defined. As defined in *Webster's Dictionary*, metrics is the extent or degree to which a product possesses and exhibits a quality, or property, or an attribute. This term is more commonly used when addressing software testing and evaluation. [TEMP]

Minimum Acceptable Requirements. {Paragraph 2.3, DoD REGULATION 5000.2-R} While not specifically defined, it can be logically inferred that minimum acceptable requirements are the minimum capabilities and characteristics that a system must possess in order to successfully accomplish all mission essential tasks. [ORD]

Objective. {Paragraph 2.3.2, DoD REGULATION 5000.2-R} The objective value is that *desired* by the user and which the PM is contracting for or otherwise attempting to obtain. The objective value could represent an operationally meaningful, time critical, and cost effective increment above the threshold for each program parameter. [TEMP, ORD, APB]

Operational Performance Parameters. {Appendix II, DoD REGULATION 5000.2-R} These are system level performance capabilities such as range, probability of kill, platform survivability, operational availability, etc. Each parameter should have an objective and threshold. [ORD]

Other Systems Characteristics. {Appendix II, DoD REGULATION 5000.2-R} A special category of characteristics that tend to be design, cost, and risk drivers. Examples include electronic counter-countermeasures (ECCM) and Wartime Reserve Modes (WARM) requirements and others as listed in Appendix II of DoD REGULATION 5000.2-R. [ORD]

Parameter. {DoD REGULATION 5000.2-R} This term is liberally used throughout the DoD 5000 series. It is not defined. As defined in the *American Heritage Dictionary*, a parameter is a variable or an arbitrary constant appearing in a mathematical expression, each value of which restricts or determines the specific form of the expression. Current usage in the DoD 5000 series and in other current literature used by the test community have broadened the definition to be equivalent to any test variable, whether formally part of a mathematical equation or not. Probability of hit is one example that does meet the technical definition of a parameter. [TEMP, ORD, APB]

Required Capabilities. {Used throughout DoD REGULATION 5000.2-R} Not defined. A commonly accepted definition is: system performance or characteristics that a system must possess in order to accomplish mission essential tasks. [ORD, TEMP, APB, Analysis of alternatives]

"WHAT TO TEST" TERMINOLOGY (CONTINUED)

Technical Performance Measurement (TPM). {Appendix III, DoD REGULATION 5000.2-R} Not defined. A common definition that is accepted in systems engineering follows: A product design assessment, which estimates through engineering analysis & tests, values of essential performance parameters of the current design of a work breakdown structure product element. [SEMP, contract]

Thresholds. {Paragraph 2.3.2, DoD REGULATION 5000.2-R} These are the minimum acceptable values which, in the user's judgment, are necessary to satisfy the need. If threshold values are not achieved, program performance is seriously degraded, the program may be too costly, or the program may no longer be timely. The spread between objective and threshold values shall be individually set for each program based on the characteristics of the program (e.g., maturity, risk, etc.). [ORD, TEMP, APB]

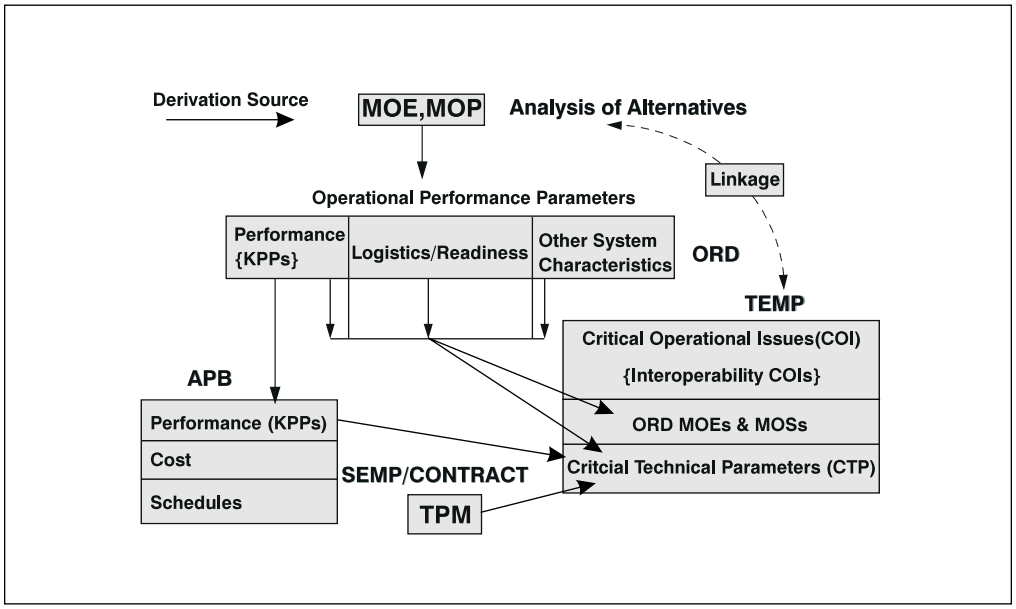

Figure 2. "What to Test'' Parameter Sources

Implementation Policy For Performance Parameter Specification

The TEMP lists the "what to test" parameters, outlines the strategy to conduct the testing, provides a summary of required test resources, and assigns responsibilities**.** *Note that the tester limits the "what to test" terminology to: measures of effectiveness, measures of suitability, measures of performance, critical technical parameters, critical operational issues, critical system characteristics and compatibility, inter-operability, and integration (CII) issues.* Terms such as software metrics, operational performance parameters, system constraints, minimum required capability and required capabilities are incorporated into the TEMP as one of the preceding "what to test" parameters, measures or issues! How do all the "what to test" parameters, measures, and issues that are commonly used by the tester tie together? Figure 3 illustrates the relationships between the "what to test" parameters during operational testing.

A critical operational issue (COI) addresses a key operational effectiveness or operational suitability issue that must be examined in operational test and evaluation to determine the system's capability to perform its mission. The COI is stated as a question and should address top system level mission essential tasks. MOEs provide (quantitative whenever practical) criteria that can be used to judge whether a system can effectively provide the required capabilities as stated in the ORD. Each MOE should provide information that is to be used to answer one or more effectiveness COIs. When a COI addresses suitability, the measure of effectiveness is replaced by the MOS. The MOP is a (quantitative when practical) criteria for a lower level of performance that is used to support the determination

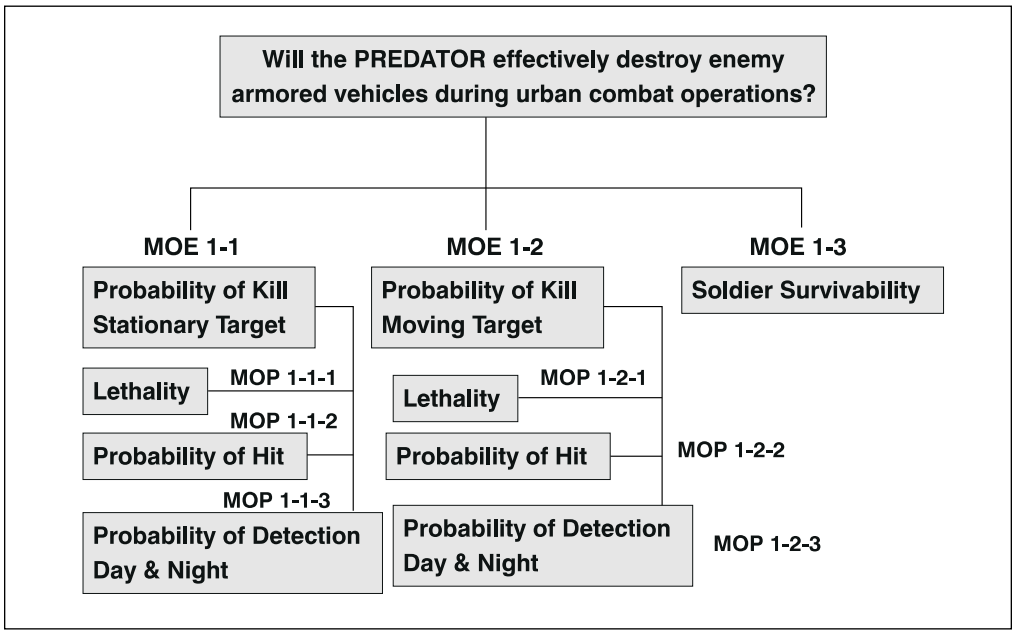

Figure 3. COI 1 {Effectiveness COI}

or assessment of one or more MOEs or MOSs. MOEs, MOSs, and MOPs are normally extracted directly from the ORD. In some cases, they must be derived from the ORD. On an exceptional basis, MOEs, MOSs, and MOPs can be recommended for testing by the Director of Operational Test and Evaluation (DOT&E) or by the appropriate component Operational Test Agency (OTA). This might occur when the OTA or DOT&E determine that the required capabilities and characteristics are not adequate for operational testing. MOEs, MOSs, and MOPs that are not extracted or derived from the ORD must be approved through the IPT process prior to being used for determination of effectiveness and suitability in an independent evaluation report such as the beyond low rate initial production report. The user will establish thresholds and objectives for any DOT&E or OTA recommended MOEs, MOSs, and MOPs.

COIs and operational performance parameters are most appropriately tested in an operational environment. An operational environment is the same or closely approximated environment that the system will be used in when issued to the user. Testing in a controlled environment that may significantly deviate from operational conditions or testing that is limited to a specific set of operational conditions is called developmental testing. Another "what to test" parameter listed in the TEMP is CTP. While MOEs and MOSs are specified to support the determination of effectiveness and suitability in an operational environment, the CTP is specified to measure progress in the hardware and software development to support the final product to be used in a fully operational environment. Developmental testing is normally the more appropriate type

of testing for CTPs. DoD guidance is that the CTP may be derived from the ORD and critical system characteristics or chosen from the list of technical performance measurements as specified in the SEMP or extracted directly from the contract. System level TPMs that measure performance essential to accomplishment of mission essential tasks should be specified to be CTPs. A possible exception to this guideline is an extremely high risk component level TPM that significantly impacts one or more system level TPMs.

In the past, specification of CTPs versus minimum acceptable operational performance parameters (MAOPRs) has been problematic. For many programs, the CTP and MAOPR lists duplicated each other. The problem arises because the ORD is an approved source for both the MAOPR and the CTP. This issue remains in the revised DoD 5000 series. The MAOPR has been replaced with MOEs and MOSs. When should MOEs and MOSs also be CTPs? This article recommends an approach to CTP specification that will minimize duplication of CTPs and operational performance parameters (MOEs, MOS, MOPs) and, more important, clearly establish a key difference between operational performance parameters and CTPs.

This process is to simply limit the specification of CTPs to performance that is contractually specified. While this recommendation is not specifically supported by guidance in the DoD 5000 series, it is well within the guidance for parameter specification. For most acquisition programs, specified performance in a contract is best tested in a controlled environment during developmental testing. TPMs are by definition contractually specified and are always a valid source for CTPs. When operational performance parameters are specified in the contract, then they should normally be specified as CTPs. This recommendation will minimize duplication between operational performance parameters and CTPs. The specification process is based on the premise that operational performance parameters are best tested during operational testing while CTPs and TPMs are more appropriately tested during developmental testing. This process recognizes that some duplication will occur between CTPs and operational performance parameters and does not restrict the testing of each type of test parameter in either an operational, developmental, or hybrid mode of testing.

Now let us address the concepts of parameter linkage and harmony. The concept of parameter linkage and harmonization was first introduced in a March 1992 memorandum that was signed by the Under Secretary of Defense for Acquisition, the Assistant Secretary of Defense (Program Analysis and Evaluation), and the Director, Operational Test and Evaluation. This memorandum mandated that the TEMP should document how measures of effectiveness and measures of performance from the COEA will be addressed in testing and evaluation. In the COEA, measures of effectiveness were to be defined to measure operational capabilities in terms of engagement or battle outcomes for weapon systems. Measures of performance such as speed and weight were to be specified to relate to the MOE such that the effect of a change in the MOP can be related to a change in the MOE. It further mandated that the MOEs, MOPs, and criteria in the ORD, the COEA, the TEMP, and the APB should be consistent. These mandates were incorporated into Part III

of the revised DoDI 5000.2 as quoted below:

> Linkage shall exist among the various MOEs and MOPs used in the analysis of alternatives or ORD, and test and evaluation; in particular, the MOEs, MOPs, and criteria in the ORD, the analysis of alternatives, the TEMP and the APB shall be consistent.

and

> Both developmental and operational testers shall be involved early to ensure that the test program for the most promising alternative can support the acquisition strategy and to ensure the harmonization of objectives, thresholds, and measures of effectiveness (MOEs) in the ORD and TEMP.

In the past, linkage was described as the process of associating (or linking) measures of effectiveness and measures of performance that were used as inputs in models and in analytic studies with actual test data and evaluated results that were based on actual test data. The purpose of this association was to ensure that realistic inputs were used in models and analytic studies. Harmonization was the process of ensuring consistency among the all the various measures and parameters to include associated thresholds and objectives. The translation of past guidance into the new DoD 5000 series has lost some of the precision associated with defining the linkage and harmonization process. Harmonization and linkage have adopted the same meaning, for practical purposes. That meaning is consistency. This consistency has three key ingredients:

- agreement on thresholds and objectives for the same measures and parameters,
- compatibility of measures and parameters, and
- realistic (consistent with test data) inputs into studies and models.

The concept of harmonization and linkage should be considered to mean the process of establishing and maintaining consistency among all the measures, parameters, and inputs to models and analytic studies. This consistency must extend to all the key acquisition documents (Figure 4).

Harmonization and linkage are most easily discussed practical examples; three follow. First, during an analysis of alternatives, assume that the threshold speed (a measure of performance) for an armored vehicle was established to be 80 km/h on improved roads. This threshold speed might be a significant input into the models and studies that recommended that tank A be the preferred alternative. Then assume that during developmental testing of a prototype tank A, it is discovered that this type of tank will not exceed 73 km/h on improved roads. It is also assumed that the engineering change proposals to increase the speed to 80 km/h is cost and schedule prohibitive. For this example, the concept of linkage and harmonization requires that actual test data for tank A on speed on improved roads be compared with inputs that were used in the models and studies that were used in the analysis of alternatives. Where necessary, previous

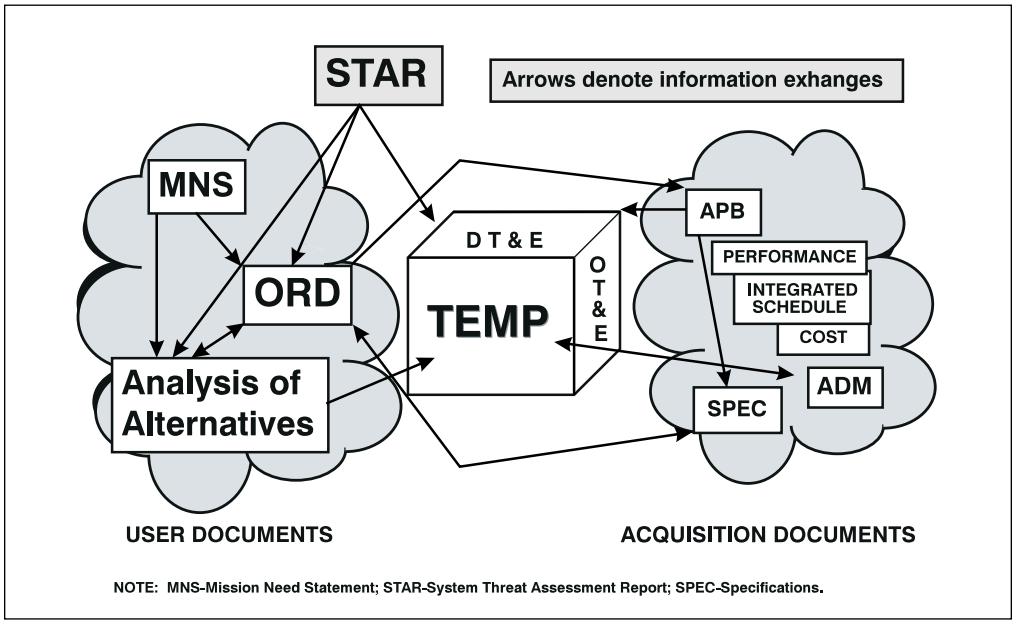

Figure 4. Parameter Consistency (Harmonization And Linkage)

inputs (measures of effectiveness and performance, system constraints, etc.) must be changed to reflect the more realistic inputs that are based on actual test data. For our example, we would have to establish whether the lower threshold speed of 73 km/h versus the earlier threshold of 80 km/h has a significant impact on the selection of the preferred alternative.

For a second example, assume the threshold for mean time between failure (MTBF) for a radio system to be 1250 h. The MTBF threshold would be listed in the TEMP, ORD and possibly in other key acquisition documents such as the APB. Assume the mean time to repair (MTTR) to be specified as 30 min at all levels of maintenance. In the analysis of alternatives, assume the system to have been required to have not more than 45 min of not available time for repairs on an annual basis. In the ORD or other user document, assume the system to have the requirement to be placed into operation for 2500 h on an annual basis. Now, the question to answer is: "Are these required capabilities and associated parameters in harmony (consistent)?" In this case, the required performance parameters are not in harmony. Simple math will reveal a discrepancy. During one year, the system should fail on average twice. Two times 30 min indicates that, on average, 60 min of downtime should be expected for this system. This conclusion indicates that the system should be expected to have more than 45 min of not available time on an annual basis. The "what to test" parameters among the TEMP, ORD, and analysis of alternatives are not consistent (harmonized). This problem can be fixed by decreasing the mean time between failure or by increasing the threshold for the not available time from repairs. The preced-

ing example illustrates the compatibility aspect of consistency.

The final example illustrates the simplest aspect of consistency. That is simple agreement of thresholds and objectives for the same operational performance parameter or other "what to test" parameter. Assume that the TEMP lists a MOP that specifies the threshold for the probability of hit for a shoulder-launched missile to be 50% for stationary targets at 600 m. In the APB, assume the threshold for probability of hit to be 60% for the same conditions. To establish consistency, the probability of hit thresholds in the TEMP and APB must be the same for stationary targets at 600 m.

Now that we have discussed the "what to test" terminology and the concepts of linkage and harmonization, it is how time to establish an orderly and efficient process to effectively specify "what to test" parameters and to establish consistency (harmony and linkage) among measures, parameters, and inputs for models and analytic studies (Figure 5).

TEST PARAMETER SELECTION, LINKAGE, AND HARMONIZATION

Step one. Establish a working-level IPT (analysis of alternatives/requirements/ what to test) that:

- specifies the required capabilities and operational performance parameters with associated thresholds and objectives in the initial ORD and the preliminary TEMP,
- inputs the required capabilities and associated operational performance parameters for each alternative considered in an analysis of alternatives,
- recommends performance parameters to be used in the draft APB,

STEP ONE:	**ESTABLISH IPT.**
STEP TWO:	**DRAFT ORD.**
STEP THREE:	**SPECIFY COI AND CII.**
STEP FOUR:	**SPECIFY MOEs AND MOSs**
STEP FIVE:	**INPUT TO APB.**
STEP SIX:	**SPECIFY CTPs.**
STEP SEVEN:	**PREPARE PARAMETER DENDRITIC.**
STEP EIGHT:	**PREPARE CONSISTENCY MATRIX.**

Figure 5. Eight-Step Process to Specify "What to Test" Parameters

- specifies the CTPs for the draft TEMP, and

- establishes and maintains consistency (linkage and harmonization) for all "what to test" parameters and criteria among all key acquisition documents. (APB, TEMP, Analysis of Alternatives, ORD, SEMP [if applicable]).

IPT membership should include representatives from the (1) user, (2) material developer, (3) operational tester , (4) developmental tester, (5) agency tasked to conduct analysis of alternatives, (6) logistics support agency, and others as appropriate. This IPT could be assigned the task of actually conducting the analysis of alternatives or be placed in support of another IPT that will perform the analysis of alternatives. In theory (in practice all the key acquisition documents are often prepared simultaneously), the analysis of alternatives is normally the first document to be drafted. The operational performance parameters that are used in the analysis of alternatives should not be system specific but should be applicable for all alternatives. The tester has the important role in this process of providing input as to how to properly state required capabilities in terms that can be tested. The user, as a member of the IPT, should take the lead in preparing a draft ORD with broadly defined system characteristics for each alternative under consideration. These draft ORDs will greatly aide in the analysis by providing a basis for numerical inputs for MOEs, MOSs, and MOPs that are used in the analysis. Step one has the following goals:

- Identify the performance and cost advantages and disadvantages between proposed systems over the existing system and/or a modified system.

- Broadly define the system characteristics needed in the new system.

- Select the preferred alternative to carry into Phase I of the acquisition cycle.

Step two. The IPT, with the user taking the lead, should then formalize the draft ORD (see step one) for the preferred alternative. In paragraph four of the ORD, list the required capabilities as operational performance parameters. The format for the ORD is prescribed in Appendix II of DoD REGULATION 5000.2-R. Results from the analysis of alternatives should be used to better define those system characteristics that are important in ensuring that the system meets the user's needs. The operational performance parameters in paragraph four of the ORD should be stated in a manner that facilitates their translation into MOEs, MOSs, and MOPs for listing in the TEMP. Each operational performance parameter should be readily identifiable and have a clearly stated threshold and objective. Examples of good and bad operational performance parameters follow:

Good: The KILLER must have a probability of kill for stationary targets that meets or exceeds 90% in the range band of 20– to 250 m during day operations in all types of weather and terrain. The desired probability of kill for this type of target is 95%.

Bad: The KILLER must have a probability of kill for moving targets that meets

or exceeds that of the legacy system.

Comments: The good operational performance parameter clearly indicates that the test parameter is probability of kill. It clearly states the threshold and objective. It also provides an adequate amount of information to establish the environment. The bad example fails to clearly state the thresholds, objectives, and environmental conditions.

A preliminary choice of KPPs should be made at this time. They will be formally approved at component level and by the JROC.

Step three. Specify the COIs and the CIIs. As part of the IPT process, the user and the operational tester should assume the lead in the specification of the COIs and CIIs. The COIs should address the top system level mission essential tasks. A good source for the identification of COIs are paragraph one and the introductory statements for paragraph four in the ORD. For example, the ORD states that a helicopter will conduct armed and unarmed reconnaissance and security operations in combat. An appropriate COI that addressed this mission essential task might be: "Can helicopter A conduct armed and unarmed reconnaissance and security operations in combat?" COIs are questions that when answered support a determination of system effectiveness and suitability. The number of COIs to adequately address effectiveness and suitability normally range from 3 to 10. The absolute minimum is 2, one for effectiveness and one for suitability.

The determining factor as to how many COIs are needed is the number of mission essential tasks. Carefully specified COIs have the potential to address more than one mission essential tasks. Each COI requires a sufficient number of MOEs or MOSs to adequately determine an answer. An excessive number of COIs tends to increase the total number of test data elements that must be collected during operational testing and should be avoided whenever possible. The CII is a special type of COI that addresses compatibility, interoperability, or integration issues. A good source for the specification of CIIs is the other system characteristics listed in paragraphs 5f and 5h in the ORD. It is possible to specify one COI that adequately addresses all the compatibility, interoperability, and integration issues. For example, "Is the KILLER compatible and effectively integrated with other systems on the battlefield? Note that this is a standalone system and has no interoperability issues."

Step four. As identified in the ORD, specify system specific MOEs and MOSs and supporting MOPs as required. List the thresholds and objectives for these operational performance parameters in matrix format (recommend by the author but not mandated by DoD REGULATION 5000.2-R) in Part I of the TEMP. The ORD also suggests that those operational performance parameters that support the determination of other parameters be designated to be MOPs. A numbering scheme should be used to reflect which parameters are MOEs and MOSs and which parameters are MOPs. For example, MOP 1-2-3 indicates that this operational performance parameter is MOP 3 and that it supports the determination of MOE 2 or MOS 2 which supports COI 1. If COI 1 is an effectiveness COI then MOE 2 is appropriate.

COI	MOE/MOST/MOP/CTP: (Parameter): Threshold/Objective	Analysis of Alternatives: Threshold/Objective	APB Parameter: Threshold/Objective
COI 1: Kill Enemy Armor?	MOE 1-1 (Probability of Kill: .9/.95	Probabilty of Kill: .9/.95	Probability of Kill: .9/.95
	MOE 1-2 (Survivability): Yes or No	Survivability	
	MOP 1-1-1 (Probability of Hit—Moving): .5/.8	Probability of Hit—Moving: .5/.8	Probability of Hit—Moving: .5/.8
	MOP 1-1-2 (Probability of Hit—Stationary): .8/.9	Probability of Hit—Stationary: .8/.9	Probability of Hit—Stationary: .8/.9
	MOP 1-2-1 (Soft Launch): Yes or No	Soft-Launch Capability	Soft Launch Capability
	MOE 1-3/CTP 3 (Weight): 20 lbs/16 lbs	Weight: 20 lbs/16 lbs	Weight: 20 lbs/16lbs
COI 2-Supportable In Combat?	MOS 2-1 (Reliability) .9/.9	Reliability: .9/.9	Reliability: .9/.9
	MOS 2-2 (Transportable): Yes or No	Transportable: Yes or No	
	MOS 2-3 (Maintenance Concept): No Maintenance Required	Maintenance Concept	
Etc.	Etc.	Etc.	Etc.

Figure 6. Consistency (Harmonization–Linkage) Matrix

Step five. If not the same IPT, this IPT should provide a recommended list of performance parameters to the IPT that is drafting the APB. Those parameters should be limited to those parameters designated as key performance parameters in the ORD. The MDA has the latitude to add other performance parameters to this list. Performance parameters that are cost drivers are candidates for inclusion as a performance parameter in the APB. The analysis of alternatives should be an excellent source document for the appropriate IPT to use to identify performance parameters that are cost drivers. For example, miles per gallon for the M1A2 tank is cost driver for life cycle costs for the tank.

Step six. Specify the CTPs. In the past CTPs and MAOPRs (now called operational performance parameters) were considered to be interchangeable. But CTPs should be considered to be distinctly different from operational performance parameters. Operational performance parameters are more appropriately tested in an operational (uncontrolled) environment; CTPs are more appropriately tested in a developmental (controlled) environment. As part of the IPT process, the material developer representatives supported by the contractor and the government technical test manager should take the lead in CTP specification. While the ORD is specifically stated to be a source for CTPs, they should be limited to system level performance that is specified in the contract. Technical performance measurements are normally used by the contractor and the government system engineers to manage the engineering development of a system. The most significant system level technical performance parameters are the best candidates for selection as CTPs. Not all system level TPMs should be designated to be CTPs—only those can be directly linked to supporting a mission-essential task from the ORD. For example, a system-level TPM might be miles per gallon under tightly controlled driving conditions. This TPM directly supports the achievement of a mission-essential task for tank mobility without refueling for some specified distance. Therefore this TPM is an appropriate CTP. Appendix III of DoD REGULATION 5000.2-R states that CTPs should include parameters from the APB. I recommend that this guidance be implemented as follows:

Those parameters in the APB that are already specified to be operational performance parameters (MOEs, MOSs, or MOPs) from the ORD need not be specified as CTPs unless those operational performance parameters are also contractually specified. Those APB parameters that are not operational performance parameters and are not contractually specified should be specified to be an operational performance parameter if the parameter is most appropriately tested in an operational environment or a CTP if more appropriately tested in a controlled environment. In either case, the specified CTP or operational performance parameter should be annotated to reflect that the source for the parameter is the APB.

Step seven. Prepare a "what to test" parameter dendritic that shows how all the test parameters are related to each other (Figure 7). This dendritic is useful in checking for consistency among the "what to test" parameters and is useful in test planning in determining what test data elements will be needed. When complete, all MOEs and MOSs must be linked to a COI. If not, specify a COI that addresses the top-level issue that the MOE or MOS addresses. All CTPs should be linked to a MOE, MOS, and in some cases directly to a COI. Note that the dendritic includes both CTPs and operational performance parameters. Those CTPs that are not operational performance parameters should be linked to COIs and MOEs, MOSs, and MOPs. This linkage is important in determining how technical performance affects required capabilities. During operational testing, the OTA has the latitude to treat a CTP that is not duplicated by an operational performance parameter in the same manner that operational performance parameters are treated. The primary differ-

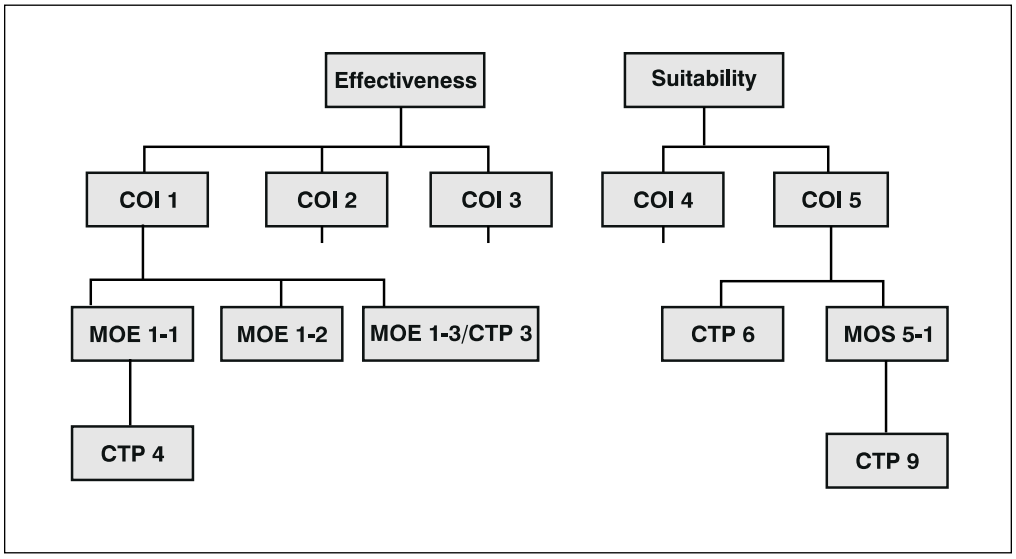

Figure 7. Test Parameter Dendritic

ence is that the environment that was controlled for testing CTPs is now uncontrolled. The OTA is not limited to previously specified thresholds for a CTP. During operational testing, the CTP is simply a criteria to be used in the evaluation and determination of MOEs, MOSs and MOPs.

Step eight. The final step in this process is to ensure that consistency (harmonization and linkage) is established between the "what to test" parameters among the key acquisition documents (TEMP, ORD, APB) and the measures criteria used in the analysis of alternatives.

CONCLUSION

This article has discussed the latest DOD 5000 series guidance on specifying "what to test" parameters, how to establish consistency (harmony and linkage), and has outlined an eight step process to implement this guidance.

This process is complicated by the complex terminology that varies within the various parts of the DoD 5000 series. A key simplification is to limit CTPs to contractually specified performance that is most appropriately tested during developmental testing. The operational performance parameters from the ORD are listed in the TEMP and are more appropriately tested in an operational environment. This type of specification process does not prohibit the test manager from testing some of the operational performance parameters during developmental testing or testing CTPs during testing that is primarily operational in nature. In fact, a wise program manager will ensure that this happens. However, this process does clearly recognize that operational performance parameters are designed for operational testing while critical technical parameters are designed for developmental testing.